

## 2.10 Geology/Soils/Seismicity/Topography

### 2.10.1 Regulatory Setting

For geologic and topographic features, the key federal law is the Historic Sites Act of 1935, which establishes a national registry of natural landmarks and protects “outstanding examples of major geological features.” Topographic and geologic features are also protected under the California Environmental Quality Act (CEQA).

This section also discusses geology, soils, and seismic concerns as they relate to public safety and project design. Earthquakes are prime considerations in the design and retrofit of structures. The California Department of Transportation (Caltrans) Office of Earthquake Engineering is responsible for assessing the seismic hazard for Caltrans projects. Structures are designed using the Caltrans Seismic Design Criteria (SDC). The SDC provides the minimum seismic requirements for highway bridges designed in California. A bridge’s category and classification will determine its seismic performance level and which methods are used for estimating the seismic demands and structural capabilities. For more information, please see the Caltrans [Division of Engineering Services, Office of Earthquake Engineering, Seismic Design Criteria](#).

#### 2.10.1.1 City of San Juan Capistrano General Plan (December 1999)

The City of San Juan Capistrano has proposed the following applicable goal and policy to reduce the risk of the community from geological hazards.

**Goal:** Reduce the risk to the community from hazards related to geologic conditions, seismic activity, wildfires, structural fires, and flooding.

**Policy 1.1:** Reduce the risk of impacts from geologic and seismic hazards by applying proper development engineering, building construction, and retrofitting requirements.

### 2.10.2 Affected Environment

This section is based on the Preliminary Geotechnical Design Report (GDR) (October 2012). The Preliminary GDR is on file and available for review at the Caltrans District 12 office.

### **2.10.1.2 Topography**

The Study Area runs north up Oso Creek Valley to about La Paz Road, where it traverses and ultimately terminates within the foothills of the San Joaquin Hills that border the south end of the Irvine Basin.

### **2.10.1.3 Regional Geology**

The Study Area is located in southern Orange County along the western flank of the Peninsular Ranges Geomorphic Province of Southern California and consists of Tertiary-aged and younger marine sedimentary rock and geologic structures that comprise the San Joaquin Hills. The San Joaquin Hills are located along the southern boundary of the Irvine Basin and are the expression of a large, broad, faulted anticline (Vedder et al. 1957; Vedder 1975). Several streams (e.g., San Juan Creek, Trabuco Creek, Oso Creek, Aliso Creek) have incised valleys and canyons through the hills toward the coast. Uplift of the San Joaquin Hills is believed to be a result of the shortening of the crust perpendicular to the southern Newport-Inglewood Fault Zone (Grant et al., 1999, 2002 and 2004). Regional geology is shown in Figure 2.10-1.

### **2.10.1.4 Soil Conditions**

Soil conditions within the Study Area are best described by segment (summarized in Table 2.10-1).

#### ***SR-73 to Oso Creek Bridge***

This segment of Interstate 5 (I-5) traverses liquefiable alluvial soils of Oso Creek to the west and bedrock-cut slopes with small intervening drainages on the east side of I-5. The small intervening channels may contain artificial fill. At the northern end of this segment, bedrock is exposed and is predominantly comprised of siltstone facies of the Capistrano Formation. Niguel Formation sandstone, which overlies the Capistrano Formation, caps much of the bordering hills.

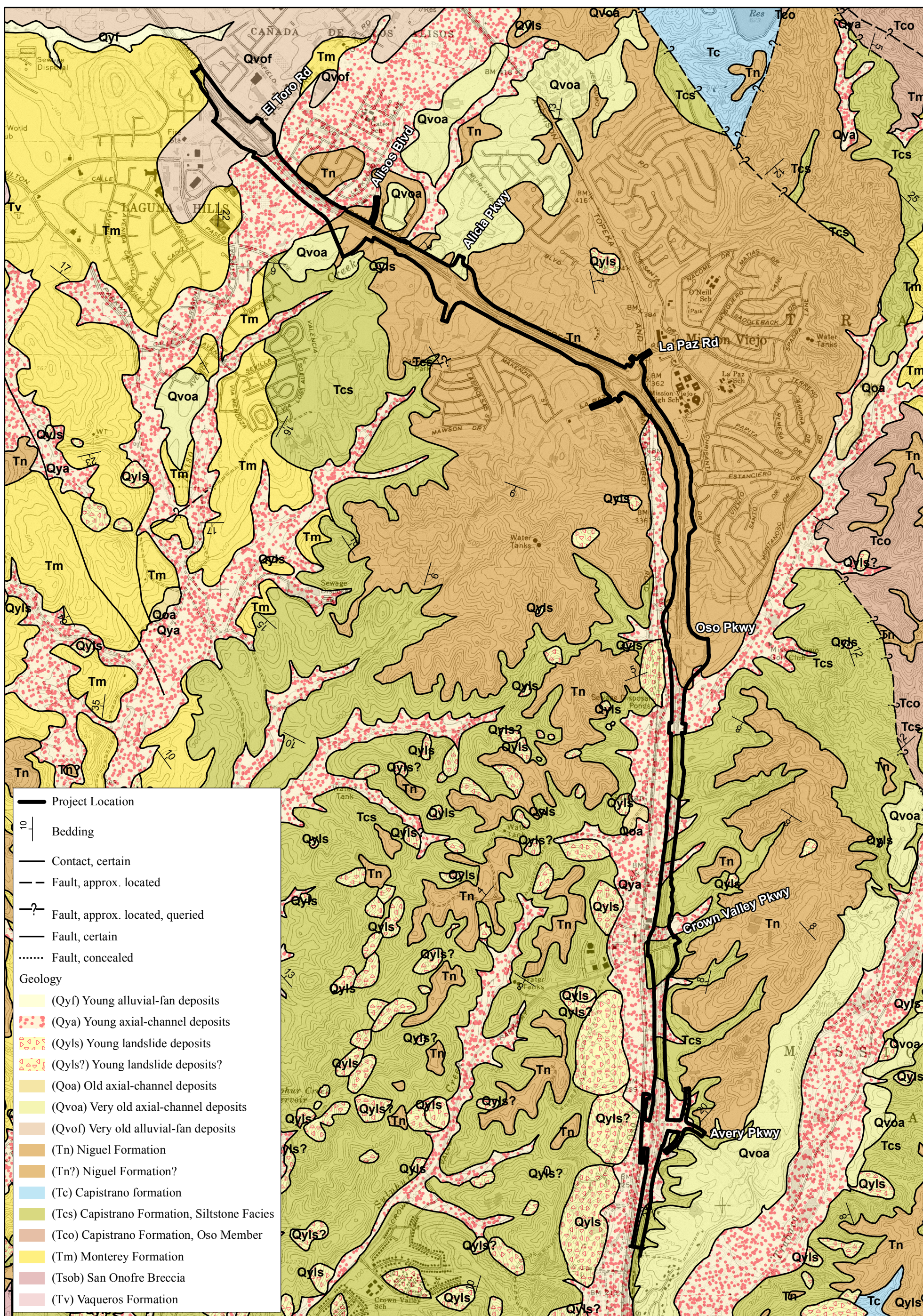
#### ***Oso Creek Bridge to Aliso Creek Bridge***

The predominant soil mapped along this segment is sandstone bedrock of the Niguel Formation.

#### ***Aliso Creek Bridge to El Toro Road***

In this section, I-5 traverses the alluvial plains bordering the San Joaquin Hills and the Irvine subbasin. The alluvial sediments generally overlie bedrock of the Monterey, Capistrano, and Niguel Formations.



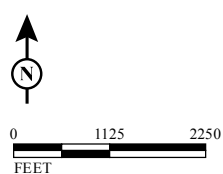


I-5 Widening Project: SR-73 to El Toro Road

## Regional Geology

12-ORA-5 PM 12.4/18.9

EA# 0K0200



SOURCE: USGS 7.5' QUAD - SAN JUAN CAPISTRANO ('81); Morton (2006)

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**Table 2.10-1 Soil Types Within the Study Area**

<b>Segment</b>	<b>Soil Types</b>
SR-73 to Oso Creek	<p><b>Artificial fill</b> – Silt, very fine sand, silty sand, fine to medium sand, buried concrete, silty clay, and sand with some gravel</p> <p><b>Alluvium (liquefiable)</b> – Silt, sand, clayey silt, gravel, clay, cobbles, and boulders</p> <p><b>Capistrano Formation (Undifferentiated)</b> – Laminated to massive diatomaceous siltstone, shale and mudstone, minor interbeds and lenses of sandstone, and interbedded sandstone and clayey siltstone</p> <p><b>Niguel Formation</b> – Sandstone, siltstone, conglomerate</p>
Oso Bridge to Aliso Creek Bridge	<p><b>Niguel Formation</b> – Sandstone, siltstone, conglomerate</p>
Aliso Creek Bridge to El Toro Road	<p><b>Alluvial Sediments</b> – Silt, sand, clayey silt, gravel, clay, cobbles, and boulders</p> <p><b>Monterey Formation</b> – Siliceous, tuffaceous, and diatomaceous marine siltstone, shale, claystone, chert, limestone, and sandstone</p> <p><b>Capistrano Formation – (Undifferentiated)</b> – Laminated to massive diatomaceous siltstone, shale and mudstone, minor interbeds and lenses of sandstone, and interbedded sandstone and clayey siltstone</p> <p><b>Niguel Formation</b> Sandstone, siltstone, conglomerate</p>

Source: Preliminary Geotechnical Report, Kleinfelder, Inc., October 2012

### 2.10.1.5 Groundwater Conditions

Within the Study Area, groundwater is generally present in the alluvial deposits found in Oso and La Paz Creeks and the drainages of the Aliso Creek Watershed.

Groundwater flow direction is toward the Pacific Ocean, generally to the south. The depth to groundwater is generally reported to be approximately 5–20 feet (ft) below the natural ground surface.

Fluctuations of the groundwater level, localized zones of perched water, and variations in soil moisture content should be anticipated during and following the rainy season (late fall to early spring). Irrigation of landscaped areas or injection or pumping of groundwater on and adjacent to the site can also cause a fluctuation of local groundwater levels.

#### **2.10.1.6 Regional Faulting, Seismicity and Surface Fault Rupture**

The Study Area is located in the seismic Southern California region within the influence areas of several fault systems. These fault systems are considered active and well-defined and are capable of producing potentially damaging seismic ground shaking. The faults that are considered active and located in close proximity to the Study Area include the Newport Inglewood-Rose Canyon Fault and the San Joaquin Hills Blind Thrust Fault. The Newport Inglewood-Rose Canyon Fault is a right-lateral strike-slip fault and is located approximately seven to nine miles (mi) to the southwest of the Study Area. The Newport Inglewood-Rose Canyon Fault is capable of generating a magnitude 7.1 to 7.5 earthquake.

The San Joaquin Hills Blind Thrust Fault is a southwest-dipping, low-angle reverse (thrust) fault that is concealed and does not reach the ground surface. This fault is approximately zero to 0.5 mi from the Study Area. The San Joaquin Blind Thrust Fault is capable of generating a magnitude 6.6 earthquake.

The Study Area is not located within a currently delineated State of California Alquist-Priolo Earthquake Fault Zone. The San Joaquin Hills Blind Thrust Fault is located approximately 1.25 mi beneath the ground surface along the northern portion of the Study Area. However, due to the nature of this fault, the potential for ground surface rupture is considered nonexistent. No other known active faults have been identified in the Study Area; thus, the potential for future surface fault rupture in the Study Area is considered low.

#### **2.10.1.7 Landslides and Slope Instability**

There are several landslides mapped in the Study Area, with the majority of these occurring as bedrock failures within the highly landslide-susceptible Capistrano Formation. Landslides are more concentrated within drainages where active erosion occurs and generally within the west (southbound side of I-5) slopes comprised of Capistrano Formation. Several slopes within the Study Area are within earthquake-induced landslide hazard zones. In general, slopes within the Capistrano Formation are highly susceptible to earthquake-induced landslide.

#### **2.10.1.8 Erosion**

Within the Study Area, most of the soils that occur have a low susceptibility to soil-slip or creep. However, where slopes are comprised of sandstone of the Niguel Formation that is poor or non-cemented, these areas are potentially susceptible to soil-slip and erosion.

#### **2.10.1.9 Liquefaction and Seismic Compaction**

Liquefaction refers to the process by which saturated, unconsolidated sediments are transformed into a substance that acts like a liquid, thereby losing its strength. The potential impacts of liquefaction to the Study Area may include:

- Settlement of ground surface
- Additional down drag forces on foundation piles as a result of soil settlement above the liquefied layers
- Reduction of shear strength of the liquefied soil, resulting in reduced load-carrying capacity. Liquefaction below areas of sloping ground may also lead to lateral slope instability (lateral spreading).

According to a Seismic Hazard Zones map prepared by the California Geological Survey (CGS) for the San Juan Capistrano quadrangles, portions of the Study Area located in the alluvium-filled drainages of the Aliso Creek Watershed and La Paz and Oso Creeks are located in designated liquefaction hazard zones.

There is a potential for lateral spreading, especially along much of the southern portion of the I-5 alignment in this area. The existing freeway is constructed adjacent to and upon the floodplain of Oso Creek Channel.

Seismic compaction or settlement is a phenomenon in which loose, unsaturated sands tend to settle or densify during strong earthquake shaking. Sediments that are sufficiently loose are subject to such densification, which can cause ground surface settlement and damage to the surface and near-surface structures.

#### **2.10.1.10 Tsunami and Seiche Potential**

Tsunamis are seismically induced sea waves generated by offshore earthquake, submarine landslide, or volcanic activity. According to the Tsunami Inundation Map for Emergency Planning, Laguna Beach and Dana Point/San Juan Capistrano Quadrangles,<sup>1</sup> the proposed project is not located within a Potential Tsunami Hazard Area.

Seiches are another type of water-related seismically induced hazard. Seiches are extensive wave actions on lakes or reservoirs. Since no major lakes or open water

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<sup>1</sup> [http://www.conservation.ca.gov/cgs/geologic\\_hazards/Tsunami/Inundation\\_Maps/Orange/Pages/Orange.aspx](http://www.conservation.ca.gov/cgs/geologic_hazards/Tsunami/Inundation_Maps/Orange/Pages/Orange.aspx), accessed January 30, 2013.

areas exist in the Cites of San Juan Capistrano, Mission Viejo, Laguna Niguel, Laguna Hills, Laguna Woods, or Lake Forest, the potential for a seiche is remote.

### **2.10.3 Environmental Consequences**

#### **2.10.1.11 Temporary Impacts**

##### ***Alternative 1 – No Build Alternative***

The No Build Alternative would not result in short-term/temporary impacts to geological, mineral, or soil resources since no construction is proposed in this alternative. Hazards associated with seismic activity will exist as it does today under the No Build Alternative.

##### ***Alternatives 2 and 3 – Build Alternatives***

Construction activities for the project such as grading and cut-and-fill slopes would disturb soil and alter existing landforms. Temporary impacts would include soil compaction and an increased possibility of soil erosion. Exposed soils would be particularly prone to erosion during construction of the project, especially during heavy rains.

#### **2.10.1.12 Permanent Impacts**

##### ***Alternative 1 – No Build Alternative***

The No Build Alternative does not involve any construction activities and would not alter existing geologic or soil conditions; therefore, it would not result in any adverse impacts to geological, mineral, or soil resources. Hazards associated with seismic activity will exist as they do today under the No Build Alternative.

##### ***Alternatives 2 and 3 – Build Alternatives***

The Build Alternatives are expected to have minimal impact on geologic and topographic conditions. The primary geologic and geotechnical constraints affecting the design and construction of any of the Build Alternatives include:

- Seismic shaking
- Landslides and slope instability
- Liquefaction and seismic shaking
- Erosion
- Corrosion

##### ***Seismic Shaking***

The potential for moderate to severe seismic shaking is likely to occur during the design life of the Build Alternatives. Strong earthquake ground shaking can be



expected to affect all aspects of the proposed project. In general, the project elements can be designed to accommodate the expected ground accelerations; therefore, the potential for structural damage can be minimized through seismic engineering design.

The structures within the project limits have been analyzed and evaluated for any needed seismic retrofit. Seismic retrofit is proposed for the Oso Creek (Bridge No. 55-0233), Aliso Creek (Bridge No. 55-0014), and El Toro Road UC (Bridge No. 55-0235) structures. These structures will be replaced and designed in accordance with the Caltrans Seismic Design Criteria (SDC), Version 1.6, dated November 2010, and applicable portions of Bridge Memo to Designers, Section 20.

At Oso Creek, as a result of the preliminary evaluation, Pier Wall Stiffeners at the pier walls built in 1961 and 1969 and a Slab Extender are proposed as a measure of retrofitting deficient confinement in the original piers. In addition, at the existing foundations, if excessive settlements due to liquefaction and lateral spreading are determined during the PS&E phase, some ground improvement methods may be considered, including, but not limited to, compaction grouting and jet grouting.

At Aliso Creek, as a result of the preliminary evaluation, Pier Wall Stiffeners at the pier walls built in 1961, 1969, and 1974 are proposed as a measure of retrofitting deficient confinement in the original piers. In addition, at the existing foundations, if excessive settlements due to liquefaction and lateral spreading are determined during the PS&E phase, some ground improvement methods may be considered, including, but not limited to, compaction grouting and jet grouting.

At El Toro Road, a retrofit of the 1969 original columns with steel casing may be required, based on the preliminary evaluation. The original bridge columns have confinement steel spaced at 12 inches on center, which is greater than the maximum allowed by SDC 3.8.2 and may be deficient in a seismic event.

All seismic evaluations will need to be verified during the PS&E phase.

### *Landslides and Slope Instability*

As stated previously, under both Build Alternatives, several slopes within the Study Area are located within mapped earthquake-induced landslide hazard zones.

Subsurface exploration and laboratory testing would be conducted during the design phase to further evaluate the potential earthquake-induced landslide hazard and to characterize the geotechnical conditions at these locations for use in further detailed analyses and slope design. Implementation of measures recommended by the Final

GDR and Structure Foundation Reports (SFRs) will ensure that there are no direct or indirect permanent adverse impacts from landslides or slope instability.

### *Liquefaction*

A portion of the project is located in an area that may be subject to liquefaction. Potential impacts due to liquefaction and seismic compaction can be reduced through proper project planning, design, and construction. During the final design phase, a site-specific Final GDR and SFRs will be prepared. The Final GDR will provide detailed analyses for the various design features, including but not limited to retaining walls and a noise barrier. The GDR will also provide soil sampling test results and geotechnical analysis regarding liquefaction, lateral spreading susceptibility, and final slope stability analyses. The SFR will provide detailed analysis per structure within the Study Area. Based on the results of the Final GDR and SFRs, the project design will include deepening the foundation and/or increasing the depth of piles or other suitable remedies. In addition, fill slopes will be stabilized by utilizing 2:1 (horizontal to vertical) slopes, assuming no liquefaction and lateral spreading. Implementation of measures recommended by the Final GDR and SFRs will ensure that no adverse direct or indirect permanent impacts from liquefaction would occur under either Build Alternative 2 or 3.

### *Erosion*

Construction of the proposed project will likely result in the alteration of existing landforms through grading activities. Alterations in landform from grading may cause erosional impacts to the existing terrain. Erosion and sedimentation in natural drainages and along natural slopes may also impact the various project elements. Applying standard engineering techniques during design and construction to prevent erosion will minimize these impacts. Typical erosion control minimization measures include improved drainage control and implementation of landscaping after construction.

### *Corrosion*

Soils derived from the Capistrano Formation and Monterey Formation that occur within the Study Area and groundwater that has permeated these formations have the potential to contain high sulfate concentrations rendering them corrosive to steel reinforcing and damaging to concrete.

#### **2.10.4 Avoidance, Minimization, and/or Mitigation Measures**

With implementation of the measures outlined below, potential long-term geotechnical concerns would be avoided and/or minimized. Short-term erosion effects during construction would be avoided and/or minimized through measures outlined in Section 2.9.

**GEO-1** Project design and construction of the Build Alternatives will be conducted in accordance with California Department of Transportation (Caltrans) guidelines, current regulations, and the California Building Code.

Specifically, structures will be designed to resist the maximum credible earthquake associated with nearby faults.

**GEO-2** During the Plans, Specifications, and Estimates (PS&E) phase, a detailed geotechnical investigation will be conducted by qualified geotechnical personnel to assess the geotechnical conditions at the project area. The geotechnical investigation will include exploratory borings to investigate site-specific soils and conditions and to collect samples of subsurface soils for laboratory testing. Those soil samples will be tested to determine liquefaction potential, collapsibility potential, stability, and corrosion potential. The project-specific findings and recommendations of the geotechnical investigation will be summarized in Structure Foundation Reports (SFRs) and a Geotechnical Design Report (GDR) to be submitted to the California Department of Transportation (Caltrans) for review and approval. Those findings and recommendations will be incorporated in the final design of the selected Build Alternative.



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